Claims

1. A dispersion compensator, comprising:

a first plurality of dispersion compensating modules, a first of said dispersion compensating modules including:

a first input port for receiving a WDM optical signal having a prescribed bandwidth;

a second input port;

first and second output ports;

a dispersion compensating element coupled to the first input port for substantially compensating each wavelength in the WDM optical signal for dispersion at a prescribed wavelength within a first sub-band of said prescribed bandwidth;

a first wavelength selective arrangement (i) directing to the second output port wavelengths received from the dispersion compensating element outside the first sub-band and (ii) directing to the first output port wavelengths received from the second input port and wavelengths received from the dispersion compensating element within the first sub-band;

a second of said dispersion compensating modules including:

a third input port optically coupled to the second output port of the first dispersion compensating module for receiving the wavelengths of the WDM optical signal outside the first sub-band;

a fourth input port;

third and fourth output ports, said third output port being coupled to the second input port of the first dispersion compensating module;

a second dispersion compensating element coupled to the third input port for substantially compensating each wavelength received from the third input port for dispersion at a prescribed wavelength within a second sub-band of said prescribed bandwidth;

a second wavelength selective arrangement (i) directing to the fourth output port wavelengths received from the second dispersion compensating element outside the second sub-band of said prescribed bandwidth and (ii) directing to the third output port wavelengths received from the fourth input port and wavelengths received from the second dispersion compensating element within the second sub-band.

2. The dispersion compensator of claim 1 wherein the prescribed wavelength in the first sub-band for which dispersion is substantially compensated is a center wavelength of the first sub-band.

3. The dispersion compensator of claim 2 wherein the prescribed wavelength in the second sub-band for which dispersion is substantially compensated is a center wavelength of the second sub-band.

4. The dispersion compensator of claim 1 wherein the first wavelength selective arrangement includes a pair of filter elements each reflecting the wavelengths received from the first dispersion compensating element within the first sub-band and transmitting the wavelengths received from the first dispersion compensating element outside the first sub-band and the wavelengths received from the second input port.

5. The dispersion compensator of claim 1 wherein the second wavelength selective arrangement includes a pair of filter elements each reflecting the wavelengths received from the second dispersion compensating element within the second sub-band and transmitting the wavelengths received from the second dispersion compensating element outside the second sub-band and the wavelengths received from the third input port.

6. The dispersion compensator of claim 1 wherein the first plurality of dispersion compensating modules includes N dispersion compensating modules, where N is an integer equal to a number of wavelength bands into which said prescribed bandwidth is to be divided.

7. The dispersion compensator of claim 1 wherein said dispersion compensating elements are single mode fibers.

8. The dispersion compensator of claim 1 wherein said dispersion compensating elements are fiber diffraction gratings.

9. The dispersion compensator of claim 1 further comprising a gain or loss element coupled to the dispersion compensating element of least one of the first and second dispersion compensating modules.

10. The dispersion compensator of claim 1 further comprising a gain or loss element coupled to the dispersion compensating element of each of the first and second dispersion compensating modules.

11. The dispersion compensator of claim 1 further comprising a second plurality of dispersion compensating modules, a first of said dispersion compensating modules including:

a first input port for receiving a WDM optical signal having a prescribed bandwidth;

a second input port;

first and second output ports;

a dispersion compensating element coupled to the first input port for substantially compensating each wavelength in the WDM optical signal for dispersion at a prescribed wavelength within a first sub-band of said prescribed bandwidth;

a first wavelength selective arrangement (i) directing to the second output port wavelengths received from the dispersion compensating element outside the first sub-band and (ii) directing to the first output port wavelengths received from the second input port and wavelengths received from the dispersion compensating element within the first sub-band;

a second of said dispersion compensating modules including:

a third input port optically coupled to the second output port of the first dispersion compensating module for receiving the wavelengths of the WDM optical signal outside the first sub-band;

a fourth input port;

third and fourth output ports, said third output port being coupled to the second input port of the first dispersion compensating module;

a second dispersion compensating element coupled to the third input port for substantially compensating each wavelength received from the third input port for dispersion at a prescribed wavelength within a second sub-band of said prescribed bandwidth;

a second wavelength selective arrangement (i) directing to the fourth output port wavelengths received from the second dispersion compensating element outside the second sub-band of said prescribed bandwidth and (ii) directing to the third output port wavelengths received from the fourth input port and wavelengths received from the second dispersion compensating element within the second sub-band;

a deinterleaver having a first output coupled to the first input port of the first dispersion compensating module in the first plurality of dispersion compensating modules and a second ouput coupled to first input port of the first dispersion compensating module in the second plurality of dispersion compensating modules; and

an interleaver having a first input coupled to the first output port of the second dispersion compensating element in the first plurality of dispersion compensating modules and a second input coupled to the first output port of the second dispersion compensating module in the second plurality of dispersion compensating modules.

12. The dispersion compensator of claim 6 further comprising a second plurality of dispersion compensating modules wherein the second plurality of dispersion compensating modules includes N dispersion compensating modules, where N is an

integer equal to a number of wavelength bands into which said prescribed bandwidth is to be divided., a first of said dispersion compensating modules including:

a first input port for receiving a WDM optical signal having a prescribed bandwidth;

a second input port;

first and second output ports;

a dispersion compensating element coupled to the first input port for substantially compensating each wavelength in the WDM optical signal for dispersion at a prescribed wavelength within a first sub-band of said prescribed bandwidth;

a first wavelength selective arrangement (i) directing to the second output port wavelengths received from the dispersion compensating element outside the first sub-band and (ii) directing to the first output port wavelengths received from the second input port and wavelengths received from the dispersion compensating element within the first sub-band;

a second of said dispersion compensating modules including:

a third input port optically coupled to the second output port of the first dispersion compensating module for receiving the wavelengths of the WDM optical signal outside the first sub-band;

a fourth input port;

third and fourth output ports, said third output port being coupled to the second input port of the first dispersion compensating module;

a second dispersion compensating element coupled to the third input port for substantially compensating each wavelength received from the third input port for dispersion at a prescribed wavelength within a second sub-band of said prescribed bandwidth;

a second wavelength selective arrangement (i) directing to the fourth output port wavelengths received from the second dispersion compensating element outside the second sub-band of said prescribed bandwidth and (ii) directing to the third output port wavelengths received

from the fourth input port and wavelengths received from the second dispersion compensating element within the second sub-band;

a deinterleaver having a first output coupled to the first input port of the first dispersion compensating module in the first plurality of dispersion compensating modules and a second output coupled to first input port of the first dispersion compensating module in the second plurality of dispersion compensating modules; and

an interleaver having a first input coupled to the first output port of the Nth dispersion compensating element in the first plurality of dispersion compensating modules and a second input coupled to the first output port of the nth dispersion compensating module in the second plurality of dispersion compensating modules.

13. The dispersion compensator of claim 1 further comprising a common dispersion compensating element for translating an average zero dispersion wavelength of the prescribed bandwidth to one end of the prescribed bandwidth, said common dispersion compensating element coupling the first input port of the first dispersion compensating module to said dispersion compensating element of the first dispersion compensating module.

14. The dispersion compensator of claim 1 further comprising a second plurality of dispersion compensating modules, a first of said dispersion compensating modules including:

a first input port for receiving a WDM optical signal having a prescribed bandwidth;

a second input port;

first and second output ports;

a dispersion compensating element coupled to the first input port for substantially compensating each wavelength in the WDM optical signal for dispersion at a prescribed wavelength within a first sub-band of said prescribed bandwidth;

a first wavelength selective arrangement (i) directing to the second output port wavelengths received from the dispersion compensating element outside the first sub-band and (ii) directing to the first output port wavelengths received from the second input port and wavelengths received from the dispersion compensating element within the first sub-band;

a second of said dispersion compensating modules including:

a third input port optically coupled to the second output port of the first dispersion compensating module for receiving the wavelengths of the WDM optical signal outside the first sub-band;

a fourth input port;

third and fourth output ports, said third output port being coupled to the second input port of the first dispersion compensating module;

a second dispersion compensating element coupled to the third input port for substantially compensating each wavelength received from the third input port for dispersion at a prescribed wavelength within a second sub-band of said prescribed bandwidth;

a second wavelength selective arrangement (i) directing to the fourth output port wavelengths received from the second dispersion compensating element outside the second sub-band of said prescribed bandwidth and (ii) directing to the third output port wavelengths received from the fourth input port and wavelengths received from the second dispersion compensating element within the second sub-band;

a splitter having a first output coupled to the first input port of the first dispersion compensating module in the first plurality of dispersion compensating modules and a second output coupled to first input port of the first dispersion compensating module in the second plurality of dispersion compensating modules; and

wherein said dispersion compensating elements in the first plurality of dispersion compensating modules provide dispersion compensation that is opposite in sign to

dispersion compensation provided by said dispersion compensating elements in the second plurality of dispersion compensating modules.

15. A method for compensating for dispersion of a WDM optical signal, comprising:

directing a WDM optical signal having a prescribed bandwidth to a first dispersion compensating element;

substantially compensating, with the first dispersion compensating element, each wavelength in the WDM optical signal for dispersion at a prescribed wavelength within a first sub-band of said prescribed bandwidth;

directing to a second dispersion compensating element wavelengths received from the first dispersion compensating element outside the first sub-band;

substantially compensating, with the second dispersion compensating element, each wavelength received from the first dispersion compensating element for dispersion at a prescribed wavelength within a second sub-band of said prescribed bandwidth; and

combining wavelengths received from the second dispersion compensating element within the second sub-band of said prescribed bandwidth with the wavelengths received from the first dispersion compensating element within the first sub-band.

16. The method of claim 15 further comprising the steps of:

directing wavelengths received from the second dispersion compensating element outside the first and second sub-bands to a third dispersion compensating element;

substantially compensating, with the third dispersion compensating element, each wavelength received from the second dispersion compensating element for dispersion at a prescribed wavelength within a third sub-band of said prescribed bandwidth; and

combining the wavelengths received from the third dispersion compensating element within the third sub-band of said prescribed

wavelength with the wavelengths received from the second dispersion compensating element within the second sub-band of said prescribed bandwidth, and with the wavelengths received from the first dispersion compensating element within the first sub-band.

17. The method of claim 15 wherein the prescribed wavelength in the first sub-band for which dispersion is substantially compensated is a center wavelength of the first sub-band.

18. The method of claim 17 wherein the prescribed wavelength in the second sub-band for which dispersion is substantially compensated is a center wavelength of the second sub-band.

19. The method of claim 15 wherein said directing step is performed by a first filter element.

20. The method of claim 15 wherein said combining step is performed by a second filter element.

21. The method of claim 19 wherein said first filter element transmits said wavelengths received from the first dispersion compensating element outside the first sub-band and reflects the wavelengths received from the first dispersion compensating element within the first sub-band.

22. The method of claim 20 wherein said second filter element transmits the wavelengths received from the second dispersion compensating element within the second sub-band of said prescribed bandwidth and reflects the wavelengths received from the first dispersion compensating element within the first sub-band.

23. The method of claim 15 wherein said first and second dispersion compensating elements are single mode fibers.

24. The method of claim 15 wherein said first and second dispersion compensating elements are fiber diffraction gratings.

25. The method of claim 15 further comprising the steps of imparting gain or loss to the first sub-band of wavelengths and imparting gain or loss to the second sub-band of wavelengths.

26. The method of claim 15 further comprising the step of translating an average zero dispersion wavelength of the prescribed bandwidth to one end of the prescribed bandwidth prior to directing the WDM optical signal to the first dispersion compensating element.

27. A method for compensating for dispersion of a WDM optical signal, comprising:

deinterleaving a WDM optical signal having a prescribed bandwidth to provide even and odd optical signals;

directing the even optical signal to a first dispersion compensating element;

substantially compensating, with the first dispersion compensating element, each wavelength in the even optical signal for dispersion at a prescribed wavelength within a first sub-band of said prescribed bandwidth;

directing to a second dispersion compensating element wavelengths received from the first dispersion compensating element outside the first sub-band;

substantially compensating, with the second dispersion compensating element, each wavelength received from the first dispersion compensating element for dispersion at a prescribed wavelength within a second sub-band of said prescribed bandwidth;

combining wavelengths received from the second dispersion compensating element within the second sub-band of said prescribed bandwidth with the wavelengths received from the first dispersion

compensating element within the first sub-band to form a dispersion compensated even optical signal;

directing the odd optical signal to a third dispersion compensating element;

substantially compensating, with the third dispersion compensating element, each wavelength in the odd optical signal for dispersion at a prescribed wavelength within a third sub-band of said prescribed bandwidth;

directing to a fourth dispersion compensating element wavelengths received from the third dispersion compensating element outside the third sub-band;

substantially compensating, with the fourth dispersion compensating element, each wavelength received from the third dispersion compensating element for dispersion at a prescribed wavelength within a fourth sub-band of said prescribed bandwidth;

combining wavelengths received from the fourth dispersion compensating element within the fourth sub-band of said prescribed bandwidth with the wavelengths received from the third dispersion compensating element within the third sub-band to form a dispersion compensated odd optical signal;

interleaving said dispersion compensated even and odd optical signals.

28. The method of claim 27 wherein the prescribed wavelength in the first sub-band for which dispersion is substantially compensated is a center wavelength of the first sub-band.

29. The method of claim 28 wherein the prescribed wavelength in the second sub-band for which dispersion is substantially compensated is a center wavelength of the second sub-band.

30. The method of claim 27 wherein the step of directing the even optical signal is performed by a first filter element.

31. The method of claim 27 wherein the step of combining wavelengths to form a dispersion compensated even optical signal is performed by a second filter element.

32. The method of claim 30 wherein said first filter element transmits said wavelengths received from the first dispersion compensating element outside the first sub-band and reflects the wavelengths received from the first dispersion compensating element within the first sub-band.

33. The method of claim 31 wherein said second filter element transmits the wavelengths received from the second dispersion compensating element within the second sub-band of said prescribed bandwidth and reflects the wavelengths received from the first dispersion compensating element within the first sub-band.

34. The method of claim 27 wherein said first and second dispersion compensating elements are single mode fibers.

35. The method of claim 27 wherein said first and second dispersion compensating elements are fiber diffraction gratings.

36. The method of claim 27 further comprising the steps of imparting gain or loss to the first sub-band of wavelengths and imparting gain or loss to the second sub-band of wavelengths.